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Strong viscous stabilization of the Rayleigh-Taylor instability at Mbar pressures[1]

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We report experimental results showing significant reductions from classical in the Rayleigh-Taylor instability (RTI) growth rate due to high pressure effective lattice viscosity. Stabilization of the RT instability by ablation and density gradients has been studied for decades. Stabilization by lattice viscosity (material strength) at Mbar pressures is new. Target samples are compressed and accelerated quasi-isentropically by plasma drives, while maintaining the samples in the solid-state. Provided strong shocks are avoided, the higher the applied peak pressure, the higher the sample strength, and hence, the higher the degree of strength stabilization of RTI [1]. This paper will present our results on vanadium (V) using the Omega long-pulse lasers and tantalum (Ta) using the Omega long pulse and EP short pulse laser in combination. The amount of RTI growth is measured by face-on radiography, utilizing a thermally driven He-α backlighter for V and a high energy ($>$ 20 keV) K-α backlighter driven by the EP petawatt laser for Ta. Comparisons with 2D simulations employing constitutive models for solid state strength suggest that we are in the new stabilization regime of very high effective lattice viscosity caused by phonon drag on dislocation motion. This effective lattice viscosity is predicted to increase with pressure, provided the lattice is maintained, making our results relevant to the fields of ICF and high energy density physics in general. Designs that extend this experiment by an order of magnitude in pressure on NIF will also be shown [2].

[1] B.A. Remington, H.S. Park et al., European Physics Journal, in press (2009).
[2] H.S. Park et al., J. Phys.: Conf. Ser. 112, 042024 (2008).

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